Final

Performance Report for the
Second Year (January 1–December 31, 1997)
of the 3-year NASA Grant NAG-1-1805 entitled

Interpretation of Trace Gas Data Using Inverse Methods
and Global Chemical Transport Models

Principal Investigator and Grantee Institution

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Attention:

(1) Dr. Jack Kaye, NASA Headquarters
(2) Dr. George Maddrea, Technical Officer, NASA Langley
(3) Grant Administrator, Grants Office, NASA Langley
(4) NASA-CASI

1. Research Objectives

This is a theoretical research project aimed at: (a) development, testing, and refining of inverse methods for determining regional and global transient source and sink strengths for long lived gases important in ozone depletion and climate forcing, (b) utilization of inverse methods to determine these source/sink strengths which use the NCAR/Boulder CCM2-T42 3-D model and a global 3-D Model for Atmospheric Transport and Chemistry (MATCH) which is based on analyzed observed wind fields (developed in collaboration by MIT and NCAR/Boulder), (c) determination of global (and perhaps regional) average hydroxyl radical concentrations using inverse methods with multiple titrating gases, and, (d) computation of the lifetimes and spatially resolved destruction rates of trace gases using 3-D models. Important goals include determination of regional source strengths of methane, nitrous oxide, and other climatically and chemically important biogenic trace gases and also of halocarbons restricted by the Montreal Protocol and its follow-on agreements and hydrohalocarbons used as alternatives to the restricted halocarbons.

2. Summary of Second Year Progress and Results

The second year has been very productive with nine papers supported by this grant appearing, in press, or submitted to peer-reviewed journals in 1997. We have continued our studies of tropospheric OH determination using multiple titrating gases. This work began with a comparison of results from CH_3CCl_3 and $CHClF_2$ (CHFC-22) (Miller *et al.*, 1997) and indicated satisfactory agreement in the OH values deduced from each. However, a study of three CFC replacements (CF_3CH_2F (HFC-134a), CCl_2FCH_3 (HCFC-141b), $CClF_2CH_3$ (HCFC-142b)) indicates that industry emissions estimates are much too low to explain observations for HCFC-141b and especially for HCFC-142b, but industry emissions estimates are adequate to account for HFC-134a observations (Simmonds et al., 1997). Hence at present only HFC-134a appears useful among these three replacements for OH determinations.

We have pursued development and testing of two types of global 3-D chemical transport models. One type is based on the NCAR CCM2 climate model whose transport we have tested by simulating CCl_3F and comparing the results with ALE/GAGE observations (Hartley *et al.*, 1994). The CCM2 does simulate some key features such as the structure (but not timing) of pollution events but there are shortcomings in other areas (e.g., cross-equatorial flow, storm track positions). The CCM2-based model has also been used to test the sensitivity of trace gas simulations to regional emission patterns (Hartley *et al.*, 1996). The other type is based on using analyzed observed winds in the MATCH model developed in collaboration with NCAR. As a precursor to the latter development we tested several moist convection and boundary layer schemes using simulations and observations of chemical tracers (Mahowald *et al.*, 1995). Initial development of the MATCH model using selected schemes from the latter study has been completed and MATCH has been tested using both short-lived (^{222}Rn) and long-lived tracers (Mahowald, Ph.D. Thesis, 1996). This thesis work has appeared in two recently published papers (Mahowald *et al.*, 1997 a, b).

We have continued our studies of the usefulness of inverse methods in 3-D models to deduce amplitudes of chemical sources and/or sinks (Prinn and Hartley, 1995; Mahowald Ph.D. Thesis, 1996). A comprehensive global process-oriented model for predicting emissions of nitrous oxide and methane has been developed, incorporated into a coupled chemistry-climate model, tested using atmospheric trace gas observations, and applied to ice-age and doubled-CO_2 climates (Liu, Ph.D. Thesis, 1996). Finally, we have recently completed development of a 3-D mesoscale model for chemistry and aerosols based on the UKMO mesoscale model and applied to a study of the role of aerosols in radiative forcing and identification of key uncertainties regarding aerosols (Pan, Ph.D. Thesis, 1996). This thesis work has appeared in three recently published papers (Pan *et al.*, 1997a, b; Tatang *et*

al., 1997). Finally, this grant has contributed to an analysis of the effects of wind shear on convective transport of chemicals (Wang and Prinn, 1997) and to modeling of $CFCl_3$ and CF_2Cl_2 (Cunnold *et al.*, 1997).

3. Journal Publications and Theses

D. Hartley, D. Williamson, P. Rasch, and R. Prinn, 1994, Examination of tracer transport in the NCAR CCM2 by comparison of $CFCl_3$ simulations with ALE/GAGE observations, *J. Geophys. Res.*, **99**, 12885–12896.

R. Prinn, 1994, Global atmospheric-biospheric chemistry, In *Global Atmospheric-Biospheric Chemistry* (Plenum Press, New York), pp. 1–18.

R. Prinn and D. Hartley, 1995, Inverse methods in atmospheric chemistry, In *Progress and Problems in Atmospheric Chemistry*, Advanced Series in Physical Chemistry (World Scientific, Singapore), Vol. **3**, pp. 172–197.

N. Mahowald, P. Rasch, and R. Prinn, 1995, Cumulus parameterizations in chemical transport models, *J. Geophys. Res.*, **100**, 26173–26189.

D. Hartley, T. Kindler, D. Cunnold, and R. Prinn, 1996, Evaluating chemical transport models: comparison of different CFC-11 emission scenarios, *J. Geophys. Res.*, **101**, 14381–14385.

N. Mahowald, 1996, Development of a 3-dimensional chemical transport model based on observed winds and use in inverse modeling of the sources of CCl_3F, Ph.D. Thesis, MIT, Center for Global Change Science Report No. 42, 199 pgs.

W. Pan, 1996, The role of aerosols in the troposphere: radiative forcing, model response and uncertainty analysis, Ph.D. Thesis, MIT Center for Global Change Science Report No. 43, 259 pgs.

Y. Liu, 1996, Modeling the emissions of nitrous oxide and methane from the terrestrial biosphere to the atmosphere, Ph.D. Thesis, MIT Joint Program on the Science and Policy of Global Change Report No. 10, 219 pgs.

D. Cunnold, R. Weiss, R. Prinn, D. Hartley, P. Simmonds, P. Fraser, B. Miller, F. Alyea, and L. Porter, 1997, GAGE/AGAGE measurements indicating reductions in global emissions of CCl_3F and CCl_2F_2 in 1992–1994, *J. Geophys. Res.*, **102**(D1), 1259–1269.

W. Pan, M. Tatang, G. McRae, and R. Prinn, 1997a, Uncertainty analysis of direct radiative forcing by anthropogenic sulfate aerosols, *J. Geophys. Res.*, **102**(D18), 21915–21934.

M. Tatang, W. Pan, R. Prinn, and G. McRae, 1997, An efficient method for parametric uncertainty analysis of numerical geophysical models, *J. Geophys. Res.*, **102**(D18), 21925–21932.

B. Miller, J. Huang, R. Weiss, R. Prinn, and P. Fraser, 1997, Atmospheric trend and lifetime of chlorodifluoromethane (HCFC-22) and the global tropospheric OH concentration, *J. Geophys. Res.*, in press.

N. Mahowald, R. Prinn, and P. Rasch, 1997a, Deducing CCl_3F emissions using an inverse method and chemical transport models with assimilated winds, *J. Geophys. Res.*, in press.

N. Mahowald, P. Rasch, B. Eaton, S. Whittlestone, and R. Prinn, 1997b, Transport of ^{222}Radon to the remote troposphere using MATCH and assimilated winds from ECMWF and NCEP/NCAR, *J. Geophys. Res.*, in press.

W. Pan, G. McRae, and R. Prinn, 1997b, Uncertainty analysis of indirect radiative forcing by anthropogenic sulfate aerosols, *J. Geophys. Res.*, in press.

C. Wang and R. Prinn, 1997, Impact of the horizontal wind profile in the lower stratosphere on the convective transport of chemical species, *J. Geophys. Res.*, submitted.

P. Simmonds, J. Huang, R. Prinn, S. O'Doherty, R. Derwent, D. Ryall, G. Nickless, and D. Cunnold, 1997, Calculated trends and atmospheric abundance of 1,1,1,2-tetrafluoroethane, 1,1-dichloro-1-fluoroethane, and 1-chloro-1,1-fluoroethane using automated *in-situ* gas chromatography-mass spectrometry measurements recorded at Mace Head, Ireland from October 1994 to March 1997, *J. Geophys. Res.*, submitted.

4. Work Proposed for the Third Year

We expect to continue our focus on two main areas in the third year.

(a) **Source-sink determinations using the 3-D global (MIT-NCAR) MATCH model**. For this model we have available the ECMWF and NMC analyzed observed winds as noted earlier. A third set of analyzed observed winds is available through the NASA-GSFC project headed by Dr. Richard Rood and we propose to test and use these as we have already done for the other two analyses. For this purpose, in the second year we transferred a version of MATCH to the NASA-NCCS computers. We will continue this year our study (begun in the second year) using MATCH together with a Kalman-filter-based inverse method to determine regional-scale emissions of N_2O and CH_4 using global atmospheric observations (AGAGE and CMDL) of these gases. The global emissions of these gases deduced from process-based modeling (Liu, 1996) are being used to define regional emission patterns (but not emission amplitudes) with the amplitudes (e.g., for five or six global regions) being deduced in the inverse method. Time-dependence in the emissions is either being specified from the process models, or deduced using inverse approaches discussed in our original proposal. For OH fields, we will use the predicted distributions from the MATCH version with chemistry, adjusted to agree with the deduced lifetime of CH_3CCl_3 from AGAGE. N_2O photodissociation rates will be obtained from the Golombek-Prinn 3-D model.

(b) **Determination of OH concentrations using inverse methods with multiple gases**. Over the past two years we have developed an inverse method which uses CH_3CCl_3, $CHClF_2$, and CF_3CH_2F observations simultaneously to provide a better constrained estimate of OH than given by CH_3CCl_3 alone. This work (done by graduate student Jin Huang) will be completed and submitted for publication in this third year. Our next step is to incorporate even more gases into the inversion, which we plan to achieve in this third year. The first gases to be added will be additional selected HCFCs and ^{14}CO for which surface emission and cosmic ray production rate data are available. A wide range of HFCs and HCFCs are being measured at the AGAGE Mace Head station and in CMDL, and will be incorporated into these multiple-gas OH estimations as emission data become reliable (see our comment in Section 2 above). These studies will use a carefully tested (with $CFCl_3$) global two-dimensional transport model developed by Drs. Chien Wang, Ronald Prinn and Andre Sokolov at MIT.

Final

NASA PHYSICS CENTERS

Summary of activities
9/1/94 - 9/1/97

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Grant NAG 9-755

GRAND SUMMARY

Summer 1994

The Physics Center activities began during the Summer 1994 as a continuation of the GTE Physics Link program.

Fall 1994

This semester there were numerous activities, such as two contests and five presentations, also the first issue of the NASA Physics Centers Newsletter. "The No-Name Newsletter" was written. The five NASA Physics Centers started activities at Andress, Del Valle, El Paso, Jefferson/Silva Magnet, and Socorro High Schools. Together they had 23 science tutors and five Center directors.

Spring 1995

This semester there were three physics contests and seven presentations, and one issue of the NASA Physics Centers Newsletter "The No-Name Newsletter." Additionally the first Physics week was held with telescope nights, a special contest and physics presentation. Again, the five NASA Physics Centers at Andress, Del Valle, El Paso, Jefferson/Silva Magnet, and Socorro High Schools had 24 science tutors and five Center directors.

Summer 1995

In our second summer, the Physics Summer Program was continued. Two physics presentations were organized and many activities were planned for the upcoming semesters. An Activity Day was held at Del Valle High School.

Fall 1995

This semester there was one physics contest and the NASA Physics Centers Newsletter "The No-Name Newsletter" was published again. Again, the five NASA Physics Centers at Andress, Del Valle, Jefferson/Silva Magnet, and Socorro High Schools had 14 science tutors and five Center directors. [The Director of the NASA Physics Center at El Paso High School retired.]

Spring 1996

This semester there were two physics contests and one presentation by Nobel laureate Leon Lederman. The NASA Physics Centers Newsletter "The No-Name Newsletter" was published again. The Physics week was held again with telescope nights, and other activities, and the first Physics Day was held at the amusement park "Western Playland." Other activities included a field trip, and an organizational meeting with high school physics teachers to create their association "Greater El Paso Physics Teachers Association." The four NASA Physics Centers at Andress, Del Valle, El Paso, Jefferson/ Silva Magnet, and Socorro High Schools had 16 science tutors and four Center directors.

Fall 1996

This semester the newsletter was named "Tlaxilhuicatl" (The sky observer in Nahuatl -- the old Aztec language). Special activities included an observation night of the last lunar eclipse of the century, and the first GEPPTA meeting. Also the first UTEP Physics Department Open House for high school students was organized. A new NASA Center at Fabens High School started, and the one at El Paso High School re-opened. The six NASA Physics Centers at Andress, Del Valle, El Paso, Fabens, Jefferson/ Silva Magnet, and Socorro High Schools had now 19 science tutors and six Center directors.

Spring 1997

New activities included the first Annual Alto Plano Physics Olympics (in collaboration with New Mexico State University), and several GEPPTA meetings. Other physics activities included a presentation of a portable planetarium at Del Valle High School, and the second "Physics Day at Western Playland." Of special importance was the field trip to Univ. of North Texas to carry out a nuclear physics experiment with five high school students and three physics teachers. The "Tlaxilhuicatl" was published again, and there were six NASA Physics Centers at Andress, Del Valle, El Paso, Fabens, Jefferson/ Silva Magnet, and Socorro High Schools with 19 science tutors and six directors.

DETAILED SUMMARY

Summer 1994

The Physics Center activities began during the Summer 1994 as a continuation of the GTE Physics Link program.

- Physics Summer Program for High School Students, from June 5 to July 7, 1994. Seven graduating seniors and 2 juniors participated. Expenses paid by College of Science.

Fall 1994

This semester there were numerous activities, such as two contests and five presentations, also the first issue of the NASA Physics Centers Newsletter. "The No-Name Newsletter" was written. The five NASA Physics Centers started activities at Andress, Del Valle, El Paso, Jefferson/Silva Magnet, and Socorro High Schools. Together they had 23 science tutors and five Center directors.

- High School Physics Newsletter, "No Name Physics Paper", October 12, 1994.

- Physics Contest: " Parachutes for Eggs", " Paper Boats", "Model Cars", at Andress High School, October 21, 1994.

- Physics Presentation for Andress High School Students, by Dr. John McClure, Material Science and applying to UTEP, October 23, 1994.

- Physics Contest, "Hot Air Balloons", at UTEP, November 3, 1994.

- Physics Presentation for High School Students, by Dr. Reta Beebe, NMSU, "Jupiter", November 3, 1994.

- Physics Presentation for High School Students, by Ginger Kerrick from NASA, at Andress High School. November 22, 1994.

- Physics Presentation for High School Students, by Ginger Kerrick, from NASA at UTEP. November 23, 1994.

- Physics Presentation for High School Students, by Dr. Robert Liefeld, NMSU at UTEP Union Theater. December 1, 1994.

- NASA PHYSICS CENTERS Participants, from September 1 to December 31, 1994:
  - Andress High School:
    Center Director: Joel king
    Student Tutors:
    Mitchell Gonzales, Yvette Hernandez, David Ramirez, Daniel Zattizahn
  - Del Valle High School:
    Center Director: Joyce Gawell
    Student Tutors:
    Francis Hoyt, Ben Muniz, Claudia Nieto, Rene Reyes
  - El Paso High School:
    Center Director: Ron Simon
    Student Tutors:
    Luis Armendariz, John Padilla
  - Silva Magnet/Jefferson High School:
    Center Director: Rafael Pena
    Student Tutors:
    Carlos Arguijo, Liza Fierro, Liza Collazo, Cynthia Fierro, Larry Gonzales, Brenda Govea, Sergio Lares, Maria Sisneros, David Tarin
  - Socorro High School:
    Center Director: Jose Polanco
    Student Tutors:
    Ramon Bautista, Maisie Maese, Jeniffer Tabullo, Michael Vasquez

Spring 1995

This semester there were three physics contests and seven presentations, and one issue of the NASA Physics Centers Newsletter "The No-Name Newsletter." Additionally the first Physics week was held with telescope nights, a special contest and physics presentation. Again, the five NASA Physics Centers at Andress, Del Valle, El Paso, Jefferson/Silva Magnet, and Socorro High Schools had 24 science tutors and five Center directors.

- Physics Contest, "Paper Plane Glider", Socorro High School. February 2, 1995.

- Physics Presentation for High School Students, by Dr. David Ernst, Chair, Physics Department, Vanderbilt University. "Los Alamos Physics", February 16, 1995. Expenses for airfare shared by New Mexico State University.

- Physics Contest, "Toothpick Bridge", at Socorro High School March 3, 1995.

- Physics Presentation for High School Students, by Dr. Verne Smith, McDonald Observatory. "The McDonald Observatory", March 8, 1995.

- High School Physics Newsletter, "No Name Physics Paper", March 12, 1995,

- Presentation on Nuclear Energy, by Robbie Bledsoe, Navy Recruiter at Andress High School. March 13, 1995.

- Presentation on Electric Car Developments and Future of Solar Cars, by a General Motors spokesman, at Andress High School. March 21, 1995.

- Physics Contests, "Paper Plane Contest", "Egg Drop Contest", and "Wooden Model Airplane Contest" at Andress High School, March 23, 1995.

- Physics Week for High School Students, at UTEP's Physics Department, April 21 to April 29, 1995.
  - Telescope Observation Night, Del Valle High School, 4/24
  - Telescope Observation Night, Jefferson High School, 4/25
  - Telescope Observation Night, Andress High School, 4/26
  - Telescope Observation Night, Socorro High School, 4/27
  - Physics Contest "Paper plane competition", at UTEP, 4/28
  - Physics Banquet for High School Teachers, 4/28.

- Physics Presentation for High School Students, by Dr. Kip Thorne, CalTech, "Black Holes and Gravity Waves", April 21, 1995.

- Physics Presentation for High School Students, by Dr. Robert Greenler, U. Wisconsin, Milwaukee, "Sunlight, Ice Crystals and Archeology", April 25, 1995.

- NASA PHYSICS CENTERS Participants, from January 1 to May 31, 1995:
  - Andress High School:
    Center Director: Joel king
    Student Tutors:
    Jennelle Barbray, Andrew Bradford,
    Pamela Heim, Jeremyu Mertens
  - Del Valle High School:
    Center Director: Joyce Gawell
    Student Tutors:
    Francis Hoyt, Ben Muniz
    Claudia Nieto, Rene Reyes
  - El Paso High School:
    Center Director: Ron Simon
    Student Tutors:
    Luis Armendariz, John Padilla
  - Silva Magnet/Jefferson High School:
    Center Director: Rafael Pena
    Student Tutors:
    Carlos Arguijo, Edna Chavez,
    Liza Collazo , Cynthia Fierro,
    Larry Gonzales, Brenda Govea,
    Claire Lopez , Veronica Reyes,
    Maria Sisneros, David Tarin
  - Socorro High School:
    Center Director: Jose Polanco
    Student Tutors:
    Ramon Bautista, Maisie Maese,
    Jeniffer Tabullo, Michael Vasquez

Summer 1995

In our second summer, the Physics Summer Program was continued. Two physics presentations were organized and many activities were planned for the upcoming semesters. An Activity Day was held at Del Valle High School.

- Physics Summer Program for High School Students, from July 10

to August 4, 1995. Eleven graduating seniors participated. High School teacher Joyce Gawell also participated. Expenses paid by College of Science.

- Books for Physics Day, "Amusement Park Physics -- A teacher's guide," by Nathan Unterman, Norfolk, June 5, 1995.

- Physics Activity Day, building and racing lego cars(calculating velocity ,etc.), building straw houses, bunny copters, etc. Del Valle High School. June 7, 1995.

- Physics Presentation for High School Students, by Dr. Pete Markowitz, Cebaf Laboratory. "Physics at Cebaf", July 19, 1995.

- Physics Presentation for High School Students, by Dr. Carlos Salgado, Norfolk State University - Jefferson Laboratory. "Physics At Jefferson Lab", July 26, 1995.

Fall 1995

This semester there was one physics contest and the NASA Physics Centers Newsletter "The No-Name Newsletter" was published again. Again, the five NASA Physics Centers at Andress, Del Valle, Jefferson/Silva Magnet, and Socorro High Schools had 14 science tutors and five Center directors. [The Director of the NASA Physics Center at El Paso High School retired.]

- High School Physics Newsletter, "No Name Physics Paper", October 12, 1995.

- Physics Contest, "Paper Caper" at Del Valle High School, November 23, 1995.

- NASA PHYSICS CENTERS Participants, from September 1 to December 31, 1995:
  - Andress High School:
    Center Director: Joel king
    Student Tutors:
    Christina Asbell, Brian Bennet,
    Kim Case, Nathan Jaquez,
    Naomi Richardson
  - Del Valle High School:

Center Director: Joyce Gawell
Student Tutors:
Roberto Montoya, Eddie Gutierrez,
Robert Rivas, Daisy Maldonado

- Silva Magnet/Jefferson High School:
  Center Director: Rafael Pena
  Student Tutors:
  Emanuel Reyes, Shirley Hernandez
- Socorro High School:
  Center Director: Jose Polanco
  Student Tutors:
  Victor Garcia, Billie Tipton,
  Hipolito Mata

Spring 1996

This semester there were two physics contests and one presentation by Nobel laureate Leon Lederman. The NASA Physics Centers Newsletter "The No-Name Newsletter" was published again. The Physics week was held again with telescope nights, and other activities, and the first Physics Day was held at the amusement park "Western Playland." Other activities included a field trip, and an organizational meeting with high school physics teachers to create their association "Greater El Paso Physics Teachers Association." The four NASA Physics Centers at Andress, Del Valle, El Paso, Jefferson/ Silva Magnet, and Socorro High Schools had 16 science tutors and four Center directors.

- Physics Contests, "Model Cars (speed, accuracy and design)", "Parachute Egg Drop" and "Paper Towers" at Andress High School, February 2, 1996.

- Physics Contest, "Floating Paper Boats" at Andress High School, February 24, 1996.

- Field Trip for High School Students. On March 1, 1997. To the Nasa Center on Boeing Street in El Paso. Tour of the NASA hangar and facilities.

- High School Physics Newsletter, "No Name Physics Paper", March 12, 1996.

- Organizational Meeting with High School Physics Teachers, to form the "Greater El Paso Physics Teacher Association", March 14, 1996.

- Books for Physics Presentation, The God Particle" by Dr. Leon Lederman, Nobel Laureate. April 11, 1996.

- Physics Presentation for High School Students, by Dr. Leon Lederman, Fermilab, Nobel Laureate. "The God Particle.", April 12, 1996. Travel expenses paid by New Mexico State University.

- Physics Week for High School Students, at UTEP's Physics Department, April 15 t0 April 19, 1996.
  - Telescope Observation Night, Socorro High School, 4/15
  - Telescope Observation Night, Andress High School, 4/16
  - Telescope Observation Night, Jefferson High School, 4/17
  - Telescope Observation Night, Del Valle High School, 4/18
  - Physics Contest, at UTEP, 4/18
  - Physics Open House, at UTEP, 4/18
  - Physics Banquet for High School Teachers, 4/19.

- Physics Day at Western Playland. Fifty Two students attended. May 18, 1996.

- NASA PHYSICS CENTERS Participants, from January 1 to May 31, 1996:
  - Andress High School:
    Center Director: Joel King
    Student Tutors:
    Monica Barndt, Paul Boentges,
    Susan Harrid, David Saldivar,
    Linda Wong
  - Del Valle High School:
    Center Director: Joyce Gawell
    Student Tutors:
    Daisy Maldonado, Eddie Gutierrez,
    Cristobal Rodriguez, Jocobel Michels
  - Silva Magnet/Jefferson High School:
    Center Director: Rafael Pena
    Student Tutors:
    Erica Esquivel , Emanuel Reyes ,
    Shirley Hernandez

• Socorro High School:
Center Director: Jose Polanco
Student Tutors:
Leslie Holguin, Billie Tipton,
Gabriela Garcia, Violet Hernandez

Fall 1996

This semester the newsletter was named "Tlaxilhuicatl" (The sky observer in Nahuatl -- the old Aztec language). Special activities included an observation night of the last lunar eclipse of the century, and the first GEPPTA meeting. Also the first UTEP Physics Department Open House for high school students was organized. A new NASA Center at Fabens High School started, and the one at El Paso High School re-opened. The six NASA Physics Centers at Andress, Del Valle, El Paso, Fabens, Jefferson/ Silva Magnet, and Socorro High Schools had now 19 science tutors and six Center directors.

- High School Physics Newsletter "Tlaxilhuicatl", September 18, 1996.

- Lunar Eclipse Viewing, at Del Valle High School, September 26, 1996.

- GEPPTA (Greater El Paso Physics Teachers Associations) Meeting, October 16, 1996.

- Physics Presentation for High School Students, by Dr. Sami Asmar, Jet Propulsion Lab, "Exploring the Solar System with a Simple Radio", October 23, 1996.

- UTEP Physics Department Open House for High School Students, October 23, 1996. With a presentation of UTEP's Physics Circus.

- NASA PHYSICS CENTERS Participants, from August 1 to December 31, 1996:
  • Andress High School:
  Center Director: Joel King
  Student Tutors:
  Lashika Sneed, Bonnie Ralls
  Elizabeth Moseley, Trisha Mears,

Margie Vela

- Del Valle High School:
  Center Director: Joyce Gawell
  Student Tutors:
  Chris Grijalva, Javier Hinojo
  Philip Chacon, Esly Ponce
- El Paso High School:
  Center Director: William Ruiz
  Student Tutors:
  Luis Armendariz
- Fabens High School:
  Center Director: James Mangold
  Student Tutors:
  Raquel Varela, Terri Hernandez
- Silva Magnet/Jefferson High School:
  Center Director: Rafael Pena
  Student Tutors:
  Arturo Acosta, Brian Namit
- Socorro High School:
  Center Director: Jose Polanco
  Student Tutors:
  Leslie Holguin, Nellyana Lafuente
  Bellie Tipton, Lucy Retana

Spring 1997

New activities included the first Annual Alto Plano Physics Olympics (in collaboration with New Mexico State University), and several GEPPTA meetings. Other physics activities included a presentation of a portable planetarium at Del Valle High School, and the second "Physics Day at Western Playland." Of special importance was the field trip to Univ. of North Texas to carry out a nuclear physics experiment with five high school students and three physics teachers. The "Tlaxilhuicatl" was published again, and there were six NASA Physics Centers at Andress, Del Valle, El Paso, Fabens, Jefferson/ Silva Magnet, and Socorro High Schools with 19 science tutors and six directors.

- GEPPTA Meeting, January 3, 1997.

- GEPPTA Meeting, at Good Luck Cafe, February 5, 1997.

- Physics Presentation for High School Students, by Susan Lea, San Francisco University, April 1, 1997. Co-sponsored by AAS Harlow Shapley Visiting Lectureship Program.

- Physics Talk to UTEP Astronomy Class, by Susan Lea, San Francisco University, April 1, 1997.

- Portable Planetarium, at Del Valle High School, during April and May of 1997.

- Physics Day, Western Playland more than 150 students attended. March 1, 1997.

- GEPPTA Meeting, at Beijing Lily, March 3, 1997.

- GEPPTA Banquet, with astronomer Susan Lea, April 1, 1997.

- Del Valle High School Hale-Bopp Comet Viewing, and informal talk by Susan Lea, April 2, 1997.

- GEPPTA Meeting, at Del Valle High School, April 2, 1997.

- "The First Annual Alto Plano Physics Olympics," events held were Egg drop, Physics Problem Solving, Flying Cylinder Contest, Fermi Questions, Paper Glider Questions. NMSU, April 19, 1997.

- High School Physics Newsletter "Tlaxilhuicatl", April 24, 1997.

- Field Trip for High School Students. May 1 to May 5, 1997. To the Accelerator Facility of North Texas State University to perform the nuclear physics experiments PIXE and Rutherford experiment. Participants: undergraduate student Jaime Morales, Adjunct Professor John Fox, and 3 high school students. Also not paid by grant two other high school students and three high school physics teachers.

- NASA PHYSICS CENTERS Participants, from January 1 to May 31, 1997:
  - Andress High School:
    Center Director: Joel King
    Student Tutors:

Hipolito Aguilera,Vanessa Bahena
Chris Camacho, Richard Coman
Angie Saenz

- Del Valle High School:
  Center Director: Joyce Gawell
  Student Tutors:
  Jessica Adame, Chris Grijalva
  Daniel Reyes, Philip Chacon
- El Paso High School:
  Center Director: William Ruiz
  Student Tutors:
  Luis Armendariz
- Fabens High School:
  Center Director: James Mangold
  Student Tutors:
  Raquel Varela, Terri Hernandez
- Silva Magnet/Jefferson High School:
  Center Director: Rafael Pena
  Student Tutors:
  Jose Delgado, Arturo Acosta
  Brian Namit
- Socorro High School:
  Center Director: Jose Polanco
  Student Tutors:
  Leslie Holguin, Nellyana Lafuente
  Bellie Tipton, Lucy Retana